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DOI: <https://doi.org/10.4081/or.2013.e23>

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ZORA URL: <https://doi.org/10.5167/uzh-90969>

Journal Article

Published Version

Originally published at:

Tscholl, Philippe M; Koch, Peter P; Fucentese, Sandro F (2013). Treatment options for patellofemoral instability in sports traumatology. *Orthopedic Reviews*, 5(3):e23.

DOI: <https://doi.org/10.4081/or.2013.e23>

Treatment options for patellofemoral instability in sports traumatology

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Abstract

Patellofemoral instability not only involves lateral patellar dislocation, patellar mal-tracking or subluxation but can also cause a limiting disability for sports activities. Its underlying causes are known as morphological anomalies of the patellofemoral joint or the mechanical axis, femorotibial malrotation, variants of the knee extensor apparatus, and ligamentous insufficiencies often accompanied by poor proprioception. Athletes with such predisposing factors are either suffering from unspecific anterior knee pain or from slightly traumatic or recurrent lateral patellar dislocation. Treatment options of patellar instability are vast, and need to be tailored individually depending on the athlete's history, age, complaints and physical demands. Different conservative and surgical treatment options are reviewed and discussed, especially limited expectations after surgery.

Introduction

Patellofemoral instability is perceived by athletes in high energy sporting activities with twisting and turning moments.¹ Anatomical risk factors for patellofemoral instability include trochlear dysplasia, patella alta, lateralized tibial tubercle.² Altered mechanical axes of the femur, poor proprioceptive and sensorimotor function and primary and secondary ligamentous insufficiency are further predisposing factors of patellar instability and dislocation.³ Biomechanically, a functional lower extremity valgus – inward rotation and adduction of the femur, and outwards rotation and abduction of tibia – is found with a high eccentric lateral contraction force of the knee extensor apparatus.¹

The incidence of lateral patellar dislocation (LPD) is highest in physically active adolescents – preferably between 10 and 17 years of age – without gender difference for the primary LPD and reaches up to 30/100,000 per year. The recurrence rate however is 3 times higher for girls.⁴ Redirection rate after con-

servative treatment has been reported to be as high as in 44% of all patients.⁵ Regardless of redirection, more than 50% of these patients suffer as a consequence from some residual pain disorders.⁵

As described by Dejour *et al.*,⁶ the pathomorphology of patients with recurrent LPD might be identical in patients with patellar subluxation. Several primary and secondary stabilizing structures of the patellofemoral joints might become painful due to microlesions or inflammation due to overload. Hence patellar subluxation is associated with patellofemoral pain, and often misdiagnosed.⁷

The goal of the following article is to give a brief overview of patellofemoral diagnostics in daily practice, and secondly an overview of known best conservative and surgical practice in patellofemoral instability especially on its implication of further physical activity and sports participation.

Diagnostics

Physical assessment

Meticulous physical examination of the patellofemoral and the adjacent joints is mandatory to depict and understand all underlying causes of patellofemoral instability and complaints which need to be addressed for successful clinical outcome. Important clinical tests and morphological signs are:^{8,9} i) medial and lateral patellar passive mobility – which shall not be larger than one to two quarters of the patellar diameter each horizontally; ii) patellar tilt test; iii) patellar apprehension test; iv) j-sign for detecting patellofemoral mal-tracking near full extension in open chain movement; v) assessment of the rotational axes of the lower extremity; vi) muscular hypotrophy.

Radiological assessment

Conventional radiographs of the knee in lateral projections are most valuable for the diagnostic of trochlear dysplasia.² The three pathologic aspects – crossing sign of the trochlear sulcus and the lateral femoral condyle, double contour as a sign of hypoplasia of the medial femoral condyle and a trochlear bump – in different combinations with axial CT imaging result in trochlear dysplasia type A to D according to Dejour.² Other indices measured routinely are the patellar height using the Caton-Deschamps index or the Insall-Salvati ratio, based on plain strictly lateral radiographs.¹⁰ However, recently the patellotrochlear index – a MRI-based measurement method – was published measuring cartilaginous overlap of the patella and trochlea on sagittal images.¹¹ This has shown higher clinical relevance.¹⁰ The tib-

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Key words: anterior knee pain, MPFL, athlete, osteotomy, trochleoplasty.

Contributions: the authors contributed equally.

Conflict of interests: the authors declare no potential conflict of interests.

Received for publication: 12 July 2013.

Accepted for publication: 22 July 2013.

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Orthopedic Reviews 2013; 5:e23
doi:10.4081/or.2013.e23

ial tubercle trochlear groove distance (TT-TG) is measured on axial CT-scans and alternatively on axial MR images also.¹² Various other measurements on the (lateral) trochlea^{13,14} and the patellar position¹⁵ have been described, but are not yet routinely used in daily practice and have yet less relevance for surgery.

Conservative treatment

Conservative treatment in primary acute LPD is the therapy of choice. It includes a multimodal approach with behavioural education of the patient, physical therapy, braces, weight reduction and pain medication.¹⁶

Physical therapy especially focuses on muscle strengthening and proprioceptive exercises. The vastus medialis obliquus muscle is described to have an important role in functional stabilization of the patella against lateral vector force. However, its training has been questioned,¹⁷ especially since muscular stabilization starts at 60° of knee flexion.¹⁸ Proprioceptive exercises and strengthening of the hip abductors and positioning of the foot are crucial, especially indicated in patient with miserable malalignment syndrome or medial collapse.¹⁹

Several patellar braces or taping methods exist to improve return to sport. They may however not alter medial or lateral displacement, but can be helpful as a diagnostic tool for occult patellofemoral instability.²⁰

Surgical treatment options

Primary acute lateral patellar dislocation

There is insufficient evidence based data, if surgical approach improves functional outcome after primary LPD compared to conservative treatment and therefore is still a matter of debate.¹⁶ Whereas no subjective benefits are found in randomized control trials with soft-tissue surgery (*i.e.* medial patellofemoral ligament (MPFL) repair, lateral retinaculum release),^{21,22} re-dislocation rates vary between 10-30% after primary stabilisation surgery and 13-52% after conservative treatment at a follow-up of more than 7 years.²¹

Most authors advice first-line arthroscopic intervention only when associated with osteochondral injury, which is found in up to 25% of acute LPD.²³ Prospective studies with MPFL-reconstruction or trochlear correcting osteotomies after first time LPD have not been performed up to date. Most studies focus on arthroscopic or open MPFL reefing and plication. However, redislocation rates are identical with conservative treatment,^{21,24} possibly due to the low tensile strength of 18% of its initial value.²⁵ Nevertheless, higher return to pre-injury sporting activity is reported after soft-tissue procedure.²⁶

Surgical treatment in recurrent lateral patellar dislocation

Up to 87% of the patients with recurrent LPD have trochlear dysplasia, lateralized tibial tubercle (high TT-TG) and/or patellar deformities.² Frequently, these patients have positive family history and complaints of patellar instability and/or bilateral LPD.⁴

Medial patellofemoral ligament

The MPFL lays extra-capsular, inserting close to the medial collateral ligament at the medial femoral epicondyle and may form an arc together.²⁷ It tears in almost 90-100% of all patients after LPD.^{28,29} It contributes up to 50% of the lateral patellar constraint until 30° of flexion.³⁰ In adults, the MPFL ruptures mostly at the femoral origin – which is associated with lower function activity level after conservative treatment injury³¹ – and in adolescents younger than 18 years of age at the patellar origine.^{3,28} Not only age, but also the TT-TG distance may influence the point of rupture,²⁸ contrary to the type of trochlear dysplasia.²⁹

There is growing evidence that MPFL reconstruction leads to promising functional outcomes after LPD,^{32,33} and to significant better results than after medial plication.³⁴ Up to 77% returned to equal sporting level³⁵ and redislocation is described in 0-10% of the patients.^{33,36,37} However complication rate –

comprising persisting instability, flexion loss and pain, hematoma, and patellar fracture – is found in up to 25%.³⁶ Biomechanical reasons are either due to failure to recognize and to address additional co-factors for patellofemoral instability or due to graft-malpositioning on the femur, which may lead to persisting instability, loss of range of motion or cartilaginous damage or just pain.^{27,38} Also the fact that the native MPFL is more elastic and less stiff than the known grafts renders malpositioning more susceptible to technical errors.²⁵ Mild trochlear dysplasia seems not to compromise postoperative results.³⁹ However, it remains unclear whether MPFL insufficiency is a subsequent injury of osseous patellofemoral instability and the cause of persisting instability in high grade trochlear dysplasia. Hence its reconstruction may not be sufficient for restoring stability.

Due to its anatomical vicinity to the MCL,²⁷ MPFL might be injured in multi-ligamentous knee trauma and lead to persisting anterior knee pain due to patellofemoral instability. The injury might be under-diagnosed during clinical examination and is rarely seen in arthroscopy.

Lateral retinaculum

The lateral retinaculum merges from the distal iliotibial tract to the superior, lateral border of the patella and contains many nerve fibres,⁴⁰ especially in patients with symptomatic patellofemoral malalignment.⁴¹ However, it has been reported that lateral release can lead to secondary medial and lateral patellar instability in knee flexion,⁴² therefore making secondary repair necessary.⁴³ Lateral retinaculum lengthening shows better results in a prospective and double-blinded study in terms of function and lesser patellofemoral instability than lateral release.⁴² Therefore, indication for lateral release became limited and should only be performed in patients in lateral hypercompression syndrome or in patients with positive patellar tilt test.³

Femoral trochlea

The trochlea plays an important role in the young athletes and adults with patellar instability and recurrent LDP of which up to 85% of the patients are dysplastic.^{2,44}

Normal trochlea is shallow in the centre, with its highest point on the lateral trochlea.¹⁴ It is the major lateral stabilizer of the patellofemoral joint after 30° of knee flexion.⁴⁵ Pathologic trochlea is mainly shallow proximally and patella dislocates near extension.¹⁴ LPD occurs most rarely in flexion.⁴⁶

Sulcus deepening trochleoplasty is the most often performed osteotomy in severe trochlear dysplasia but represents a technically demanding technique. That operation corrects the anatomical anomaly and renders the patellofemoral joint stable,^{47,48} but may

increase the risk of osteoarthritis by articular incongruence.⁴⁹ Therefore, pronounced osteoarthritis and open growth plates represent the major contraindications for this procedure.⁵⁰ Recurrent LPD after trochlear correcting osteotomy is rare and therefore most patients can improve their physical activity.⁴⁷⁻⁴⁹ However, improvement on pain scores is less predictable, wherefrom 10-30% showed increased pain.^{47,49} This might be due to degenerative changes found in 37% after 4 years follow-up.⁴⁷

It is widely discussed whether closing patellar wedge osteotomy in case of severe patellar dysplasia might be an adequate, additional treatment option to improve post-operative outcome.⁵¹

Tibial tubercle

The lateralized tibial tubercle and the patella alta are important risk factors for patellar instability and can be approached by tibial tubercle osteotomy as single or combined surgery, being transferred medially, ventrally and/or distally.^{3,52} The basic idea is on the one hand to lower the patella and on the other hand reducing the Q-angle, hence reducing lateral knee extensor vector force on the patella and articular pressure. However since the Q-angle in patients with patellar subluxation is already reduced in knee extension and Q-angle varies substantially depending knee flexion, this procedure may lead to increased retropatellar pressure on the medial femoral facet,⁵³ and secondary medial patellar instability may result.³ Therefore tibial tubercle transfer is indicated when TT-TG distance reaches a pathological values of more than 20 mm.²

After Emslie-Trillat procedure, redislocation is rare (2-13%),^{54,55} almost all patients have same sports activity – in the mean Tegner Score increases from 3.6 pre-operatively to 4.3 after surgery – and satisfactory outcome is found in 73% of the patients.^{56,57} However, the incidence of patellofemoral osteoarthritis is 42% after ten years follow-up.⁵⁴

In the varus knee, medialization of the tibial tubercle should be performed with caution, due to potential aggravation of medial gonarthrosis.⁵⁸

Femoral antetorsion

Rotational variants of the femur with increased femur antetorsion angle above 20° are pathologic and described as a co-factor of patellofemoral instability. Some authors indicate a corrective distal femur derotational osteotomy above 30°.⁵⁹

The rational of this procedure is to place the femur under the patella instead of adapting the patella to the trochlea as in tibial tubercle osteotomy, since distal femoral alignment does not match to the proximal knee extensor apparatus.⁵⁹ This procedure however is rarely mandatory and its results controversial.

Anterior knee pain associated with patellofemoral instability

Skeletal geometry, soft tissues stabilizers, and neuromuscular control guarantee perfect stability and a normal patellofemoral gliding mechanism. Anterior knee pain is very common and as high as in 20% of the athletes during one season.⁶⁰ The common symptoms of patients with functional subluxation are pain and discomfort rather than instability. Hence, clinical assessment of patients with anterior knee pain is challenging and crucial, since an event of patellar maltracking like LPD is missing and several risk factors as osseous stability, lateral muscular vector force, ligamentous instability or constraint and torsional disadvantages need to be addressed or compensated. Origin of the pain can be the synovium, the patella, its aponeurosis, the fat pad, the tendinous, retinacular and ligamentous insertions, or in young patients also hip disorders.⁶¹

Conclusions

Conservative or operative treatment option must be tailor-made. Whereas stability can significantly be increased by several surgical treatment options compared to conservative treatment, pain control is not predictable.⁵ Some major factors need to be kept in mind.

The recurrence rate of LPD after first traumatic event is 17%, whereas patients with more than one LPD have a risk of 49% for re-dislocation.⁴

LPD in early years and female gender correlates with higher risk of persisting chronic instability without surgical intervention.⁴

Increasing age is associated with decreased physical activity after surgical stabilization.

Therefore in still growing and very active athletes early surgical treatment intervention needs to be considered. Reconstruction of the MPFL in patients with minor trochlear dysplasia is technically possible without interfering with distal growth plate of the femur,⁶² however, large studies are missing. Osseous articular correction before epiphyseal closure is contraindicated.⁵⁰

In adult patients with recurrent LPD and without trochlear dysplasia or type A or C according to Dejour classification, MPFL reconstruction alone might be beneficial, in which unchanged osseous or dynamic instability will be compensated.⁴⁷ Patients with an important supra-trochlear spur as in type B and D trochlear dysplasia and chronic instability are more reluctant to conservative and soft-tissue surgical treatment options.⁴ In such cases sulcus-deepening trochleoplasty should be performed.⁴⁷ In our opinion and experience, post-surgical results are more favourable when

instability was the main symptom. Hence, in such patients low-pivoting physical activity may be re-achieved.

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